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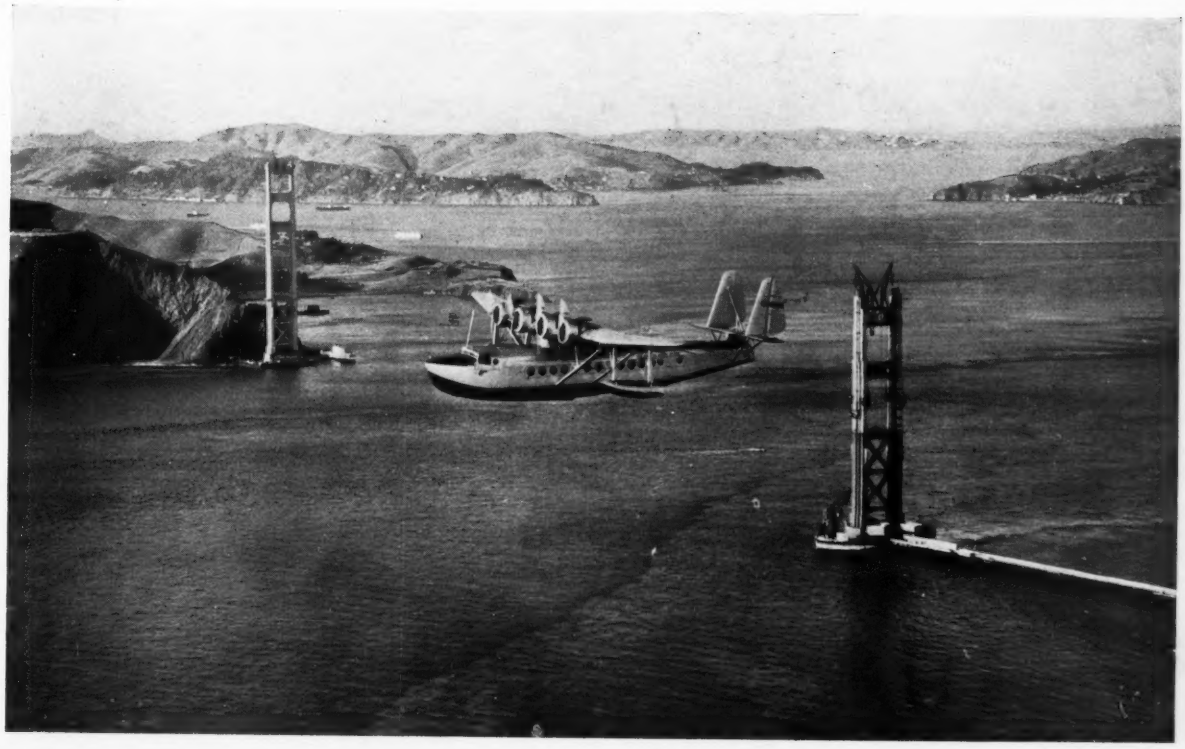
The CORNELL ENGINEER



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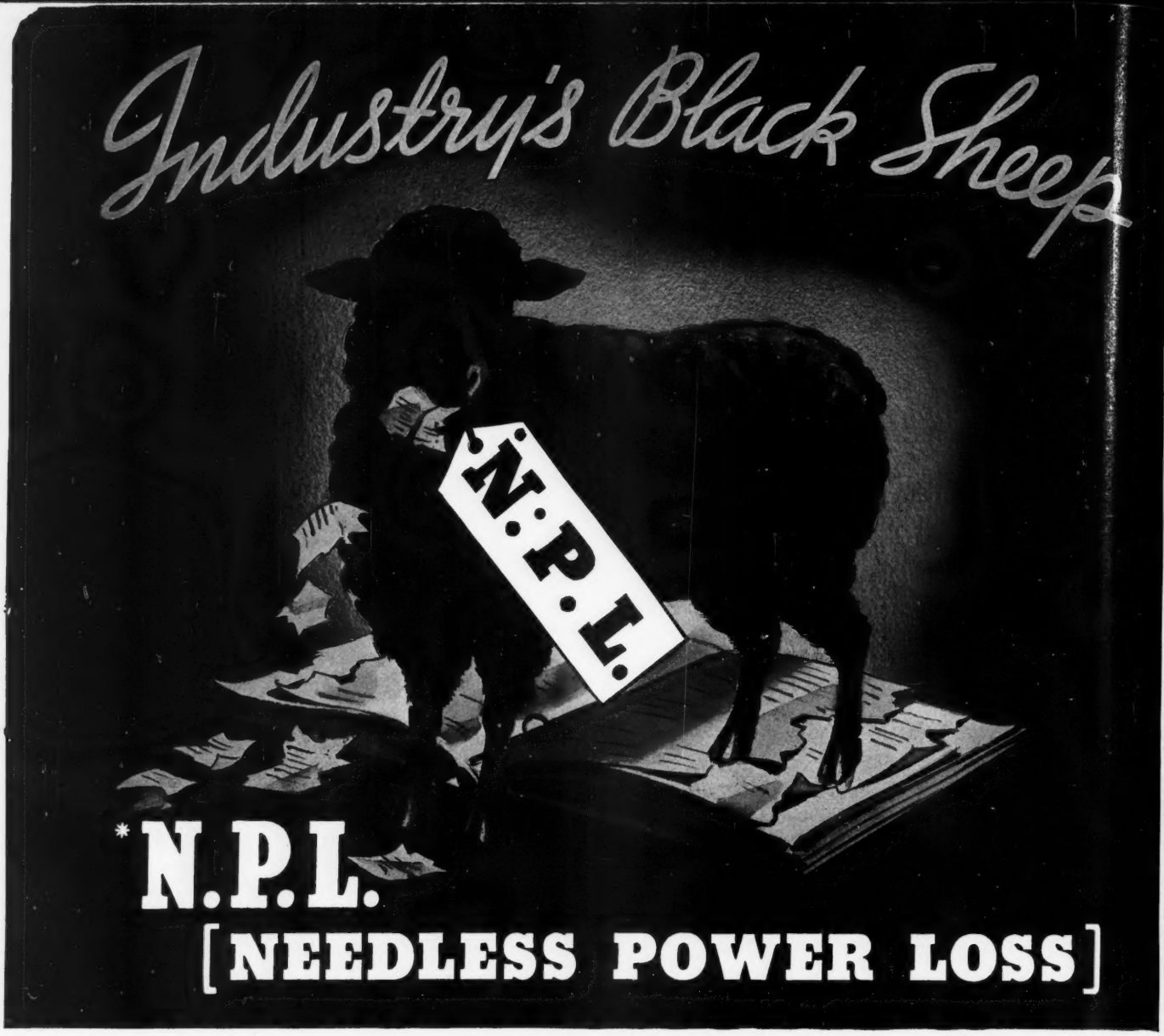
ALLOY STEELS *by* W. J. Priestly

Volume 1 APRIL, 1936 Number 7

Industry's Black Sheep



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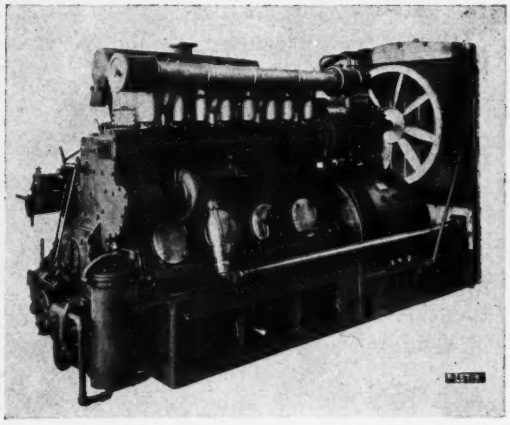

While your motor doesn't look like this, it needs even more care because of the weather to which it is exposed.

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Time-Space Photo

Fig. 7—Cro Magnon M. E. '0000, demonstrates his first invention before the Society of Engineers. Report; "Unsatisfactory."

ENGINEERING

CRO. G. MAGNON, ALIAS SLIDERULE MAGNON, THE FIRST MECHANICAL ENGINEER, DEVELOPS METHOD FOR OPENING CAN OF SARDINES. (See Fig. 7)

This *Time-Space* photo of the First Engineer shows very clearly that the sardine-can opener was invented many, many years ago.

We regret to have to report however, that no improvement has been made in this contrivance since its originator first struggled with it; and to this day, it is still quite impossible to make the damn thing work.

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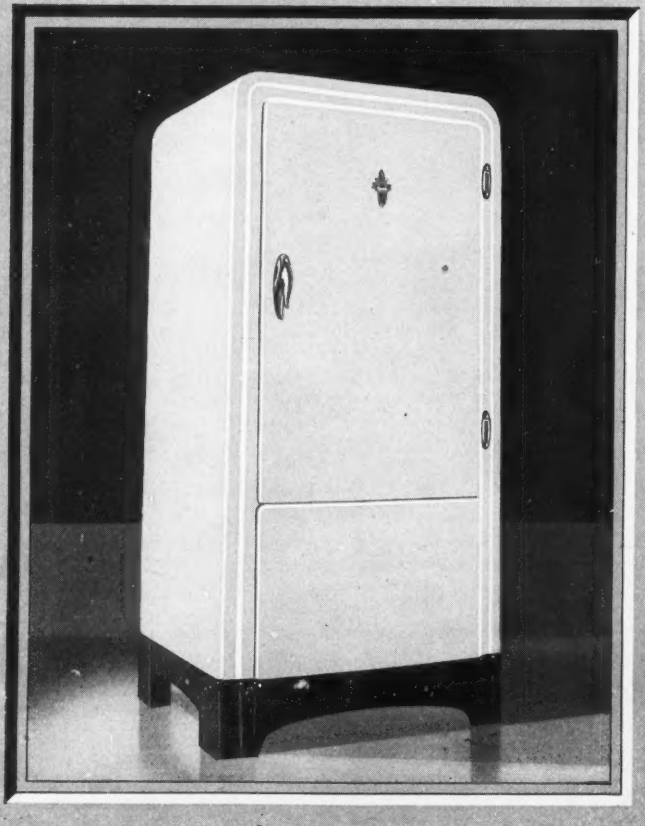

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OXWELD WELDING AND CUTTING APPARATUS AND SUPPLIES

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Volume I APRIL, 1936 Number 7

COMMENT

Mr. Priestly discusses the use and the reasons for the use of alloy steels in modern engineering.

* * *

Chrysler's Chief Engineer, Mr. Woolson, gives an interesting insight into the makeup of the modern motor car.

* * *

A widely used process in sewage treatment sludge digestion is developed at length by Mr. Gavett, an alumnus.

* * *

Prof. H. N. Ogden, another great teacher, is given the honors this month by our biographer, Mr. Davidson.

* * *

Cornell Day is the big event for both alumni and prospective students on May 16. President Stahl desires the cooperation of all the alumni to make it a success.

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Pan-American Clipper passing towers of Golden Gate Bridge ..... Cover
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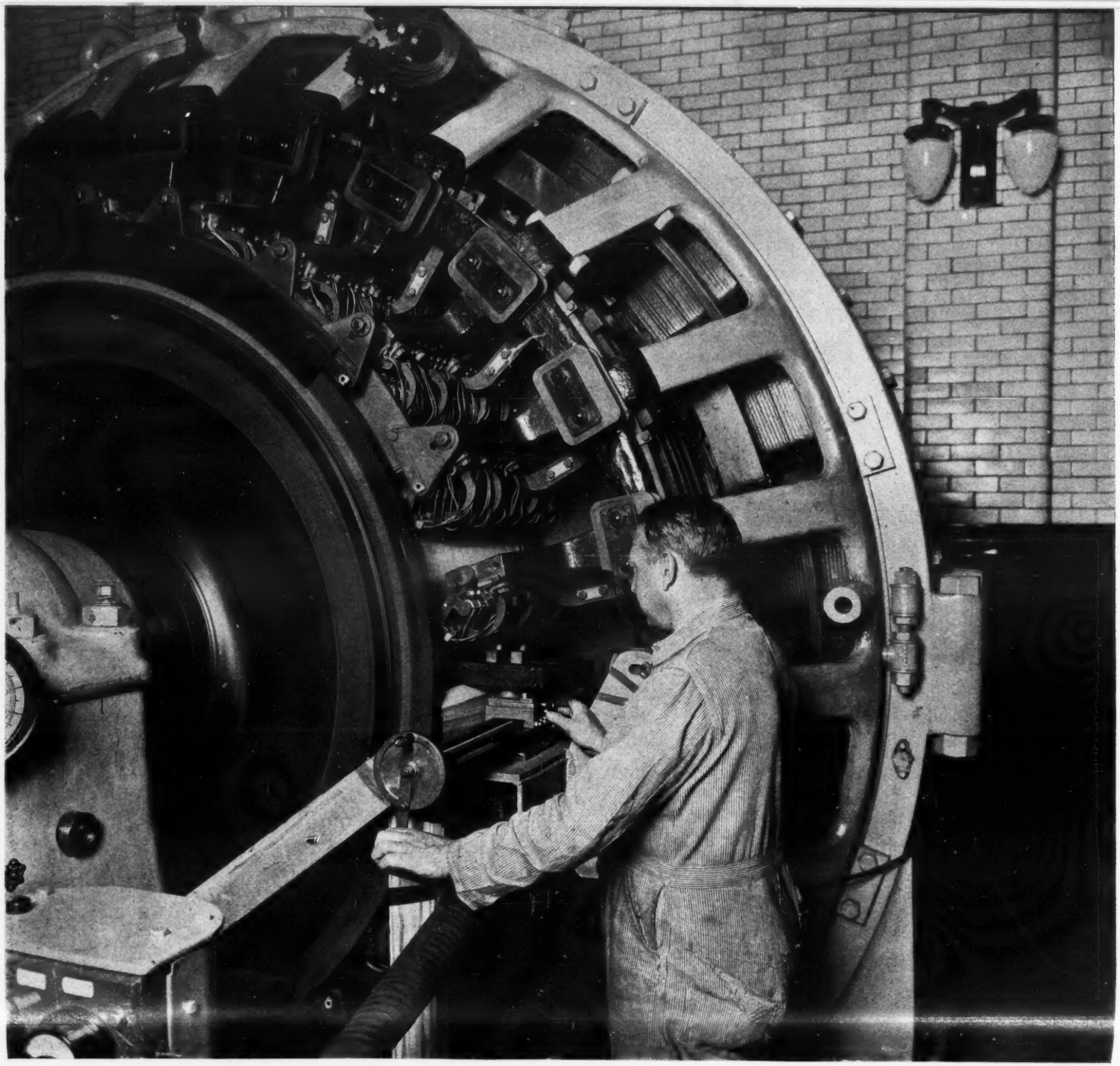


SYNCHRONOUS CONVERTER AT CONGRESS SUBSTATION . . . —*Courtesy Synchronizer*

SYNCHRONOUS CONVERTER AT CONGRESS SUBSTATION —Courtesy Synchronome

THE CORNELL ENGINEER

Vol. I April, 1936 No. 7

Alloy Steels

By William J. Priestly

Steel is in the news again. The remarkable revival of the automobile industry, advances in railroading as typified by the new streamline trains, completion of the super-liners, Normandie and Queen Mary, renewed building activity, new products and processes, are all making headlines in which steel figures prominently. Increased activity in this basic material has for years been a sign of rising business prosperity and, again, steel is in the foreground of the news.

This time, however, a new word is being used in conjunction with steel. ALLOY STEEL, says the news and thereby emphasizes one of the greatest technological developments in a decade; greater by far than the completion of a supership or the breaking of a new speed record. The progress that has been made in alloy steels in the past ten or twenty years is remarkable. It is the unqualified belief among many experts that in the future alloy steels will play an even more important role than they do at present.

The Age of Steel

Though alloy steels are something new, plain carbon steel is an old material, its use dating back several thousand years. Application were limited, however, by production difficulties which persisted almost unchanged until the eighteenth century. The crucible process for making steel was introduced in 1740; but this process was also limited to rather small scale operations, and the real advent of low-priced good-quality steel did not occur until 1855. In that year the Bessemer process was patented. This process together with the open hearth method developed a few years later, really opened up the age of steel. The electric furnace method was introduced in 1900 and has become an important factor in steel production, especially in regard to the alloy steels.

Ordinary steel is essentially an alloy of iron and carbon. It has gained its place as the most widely used metal in the world due to three factors: first, the occurrence of large deposits of high grade iron ore throughout the world; second, the fact that it is reducible by the cheapest and most readily available reducing agent—carbon; and finally, its unique characteristic of forming several distinct crystal forms at various temperatures and percentages of carbon. The first two factors assure a plentiful supply of cheap metal and the third, a wide variety of very desirable properties in the finished product.

The first two factors need no enlarging—their importance is self-evident. A short discussion of the third factor is important, however, in a discussion of alloy steels, especially in regard to the relationship of iron and carbon in steel.

Steel Made Up of Several Constituents

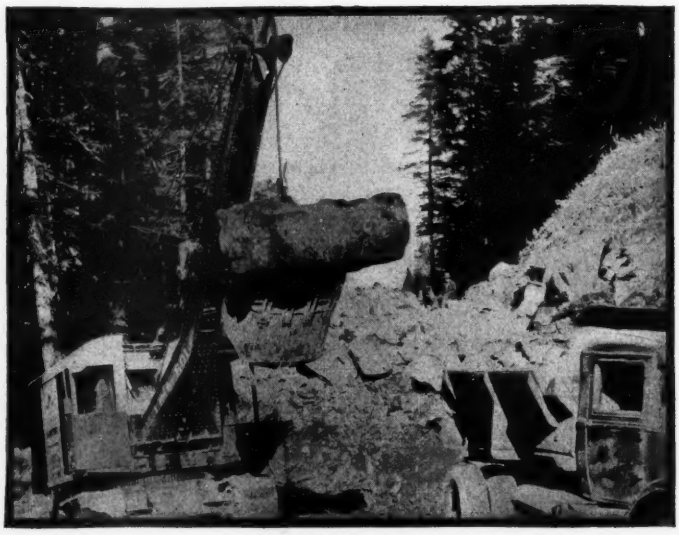
Pure iron is a relatively soft malleable material with a tensile strength at room temperatures of approximately 40,000 lb. per sq. in. It exists below the melting point in two allotropic forms. One is found at low temperatures and is called alpha iron. It also exists at high temperatures in which condition it is often referred to as delta iron. Intermediate, but also at high temperatures, is the other crystal form known as gamma iron. These allotropic forms of iron will dissolve small amounts of carbon forming solid solutions. The solid solution of carbon in the low temperature alpha iron form is known as ferrite. As the amount of carbon dissolved is exceedingly small, 0.05 per cent or less, the constituent ferrite is similar to pure iron in that it is soft and ductile. The more important high temperature form, gamma iron, is capable of dissolving up to 1.7 per cent of carbon at high temperature and this solid solution is known as austenite. Austenite, while stable at high temperatures, is readily decomposed upon cooling unless special alloying treatment is given the steel. Ausenite is strong and tough and, as will be discussed later, is sometimes a desirable constituent to have in steel.

Iron and carbon also form a compound, Fe_3C, called cementite, which is hard and brittle. The two constituents, ferrite and cementite, form a eutectic mixture called pearlite that contains approximately 0.83 per cent carbon and which is quite hard and very strong. By special heat-treatment another extremely hard transition constituent called martensite may be formed.

In plain carbon steel then, by heat-treatment and car-

bon control, may be formed by the constituents ferrite, cementite, pearlite, martensite, and possibly austenite, within certain limits. As ferrite is soft and ductile, cementite hard and brittle, pearlite fairly hard and strong. martsenite very hard and austenite strong and tough, it is evident that the physical properties of plain carbon steel may be varied at will, again within certain limits. For modern engineering processes, however, materials are demanded with properties which constantly exceed these limits. It is for this reason that alloys are added to steels—to broaden the range of properties obtainable in carbon steels, and also to impart entirely new properties.

In most ordinary steels that are usually classified as plain carbon steels, there are small percentages of elements other than carbon and iron. Silicon, manganese, phosphorus, and sulphur are commonly found in these steels. The term "alloy steel" therefore means something more than steel with other elements present. Broadly speaking, an alloy steel is one to which has been added enough of an element other than carbon to affect its properties—mechanical, chemical, physical or electrical.



Austenitic manganese steel is widely used in excavating equipment because of its high resistance to abrassion.—*Courtesy Electro Metallurgical Co.*

Many Alloys Are Added to Steel

The elements that are used at present as alloys in steel constitute an imposing list. The more important ones are Manganese, Silicon, Chromium, Aluminum, Nickel, Tungsten, Copper, Molybdenum, Zirconium, and Vanadium. In addition to these, there are numerous other elements that are used to a lesser extent. A partial list includes Titanium, Calcium, Selenium, Columbium, Nitrogen, Phosphorus, and Cobalt. A large percentage of these alloys are added to steel in the form of ferro-alloys which are essentially combinations of iron and the desired element.

These alloys are added to steel to have some effect on its properties. To have the desired effect it is evident that they must either form a new constituent, intensify the effect of, or impart new properties to, one or more of the basic constituents, or make it possible to obtain easily any desired basic constituent or constituents by affecting the rate of transformation from one constituent to another. In regard to the alloy steels in use at present, the last two factors seem most important.

The alloying elements themselves may be roughly divided into three classes, according to their characteristic action in steels. Chromium, vanadium, molybdenum, tungsten, columbium, and titanium are primarily carbide or cementite forming elements and secondarily ferrite forming. Silicon, aluminum, zirconium, and calcium are primarily deoxidizers and cleansers and secondarily ferrite forming elements. Manganese, nickel, and copper are austenite forming elements. This broad classification gives a clue to the properties of the resultant alloy steel that is obtained by the inclusion of any of them in steel.

The Cementite and Ferrite Forming Elements

The properties that are obtained in steel by the addition of the first class of elements, the cementite and ferrite formers, can best be illustrated by a discussion of chromium.

Chromium in small amounts in steel is found mostly in the cementite as double chromium-iron carbides. Cementite that contains chromium is more stable than ordinary cementite. A small amount of chromium also goes into solution in the ferrite and strengthens and hardens it. The resulting effect of small amounts of this element is to make steels stronger and tougher without incurring serious loss of ductility. The presence of chromium in steel also slows down the transformation from one constituent to another. The chromium alloy steels are consequently made for uses that will demand fully the properties that are available from the above-noted effects.

A notable series of chromium steels is the carburizing steels containing 0.60 to 0.90 per cent chromium. The advantages conferred by the presence of this element are greater hardness and wearing properties of the surface case and greater strength and homgeneity of the core. Another series of chromium steels is the engineering series which includes many steels used in the heat treated condition for automobile and machine construction. This series contains 1.00 to 1.50 per cent chromium and is recommended for parts requiring greater strength and toughness as axles and shafts. Chromium is widely used in bearing steels as races, rollers and balls, a popular specification being 1.2 to 1.5 per cent chromium and about 1.0 per cent carbon. Chromium is also used as a hardening and toughening agent in many tool steels. Several low price magnet steels also contain this element in amounts from 2 to 4 per cent. An important new steel is

one with 3 per cent chromium which has shown great promise as a rail steel. Rails of this material in actual service have outlasted all standard types of rails.

These are but a few of the chromium steels. This element is often used in conjunction with others to produce complex alloy steels. In addition to the properties already mentioned as being given to steel, chromium also contributes resistance to corrosion. It must be remembered that, while chromium is typical of elements of the first class, the other elements of this group do not have exactly the same effect as chromium. The different elements impart properties that differ at least in degree from one another and are therefore used in different ways.

The Deoxidizing Elements

The elements of the second class are perhaps the most important to steel makers because almost every ton of steel made, plain or alloy, has been cleansed or deoxidized by one of these elements. Silicon is the most important element in this group and may be considered as fairly typical.

Silicon has a great affinity for oxygen and is added during the steel making process to combine with and to eliminate this element. It is usually used in conjunction with manganese, which also acts as a deoxidizer and cleanser. When added to steel in an amount greater than that necessary to thoroughly deoxidize the steel the remaining silicon enters into solid solution with the ferrite, considerably strengthening this constituent. Most steels contain small percentages of silicon. In some the percentage is so large that the silicon has a definite effect on the steel and the result is a silicon alloy steel.

A considerable portion of spring steels, especially those used in railroad work are silicon alloy steels containing about 2 per cent silicon. Another widely used series is the silicon structural steels which are used considerably in highly stressed members of bridges. In the George Washington and Triborough bridges in New York City, silicon structural steels have been used extensively. A steel containing about 4 per cent silicon is used for transformers, generators, motors and other electrical apparatus in which high magnetic permeability and electrical resistance combined with low hysteresis are essential. It has been estimated that this last named alloy steel alone contributes hundreds of millions of dollars annually to industry in the form of increased efficiency of electrical apparatus.

The Austenite Formers

In the third class which includes the austenite-formers, are manganese, nickel and copper. By using manganese as an example, a general idea of the group may be obtained.

Austenite is a tough and ductile constituent of very high strength. It is essentially unobtainable in carbon steels at normal temperatures. The presence of 13 per cent of manganese so changes the microstructure, however, that the steel when properly heat-treated is essentially austenitic at room temperatures. The 13 per cent austenitic manganese steel is famed as one of the first true alloy steels ever developed. It is widely used for wear and shock resistant machinery parts, such as crusher tools and dipper teeth.

In smaller amounts manganese produces a structure possessing greater strength than ordinary steel. It is used for this purpose in many grades of steel whether intended for castings, forgings, or rolled products A manganese-vanadium steel is attracting considerable favorable attention of late as a mild-alloy, high-tensile steel for the construction of apparatus where reduction of dead load is important

The splendor of the Empire State Building is enhanced by trim of 18-8 chromium-nickel austenitic stainless steel.—*Courtesy Electro Metallurgical Co.*

Many Complex Alloys in Use

A large percentage of alloy steels in use today are made up with elements taken from all three classes. It

is in these complex alloy steels that the greatest promise of future expansion seems to lie. At present there are two classes of complex alloys well worth mentioning. The first is the group of complex S.A.E. (Society of Automotive Engineers) engineering steels such as chromium-molybdenum-nickel steels and others, which are a normal advancement over the simpler alloy steels. Many of these are being developed for specific machine parts which require closely defined physical properties.

The second class of complex alloy steels is the mild-alloy high-tensile group which has made such important strides in the last two years. These steels, of which Cromansil may be taken as typical, are playing a large role in the modernization of the railroad industry. The basic reason behind the development of these steels was the quest for a material that, in the "as-rolled" or non heat-treated condition, would be considerably stronger than the plain carbon steels, that could be fabricated by the latest welding methods, could be worked into shape without loss of valuable properties and which could be produced at a cost not excessive over that of plain carbon steels. Cromansil, for example, is a balanced alloy steel of the following approximate composition: 0.5 per cent chromium, 1.0 per cent manganese and 0.7 percent silicon. In the "as-rolled" condition it has a tensile strength of 80,000 to 90,000 lb. per sq. in. and may be successfully fabricated into any desired shape. This steel and the dozen or more new steels similar to it, are exceedingly valuable in the construction of lighter-weight railroad rolling stock.

Other Alloy Steels Combat Heat and Corrosion

In the above discussion, mention of several types of alloy steels has purposely been avoided. These are the corrosion and heat-resistant types, and discussion of these classes is separate because it involved metallurgical phenomena not found in carbon steel or any of its constituents. All plain carbon steels, whether high or low in carbon, are subject to corrosion. Not until certain alloys were included in steel was any degree of corrosion—or heat-resistance found. The terms "corrosion-resistant steels" and "heat resistant steels" necassarily imply, therefore, alloy steels.

The heat-resistant steels are those which exhibit either strength at high temperatures or resistance to scaling at high temperatures or both. In all the non-scaling types and several of the extra strength types, chromium is the prominent alloying element. Molybdenum and nickel are often used in conjunction with chromium to improve further the properties of these steels.

The corrosion-resistant steels always contain either copper, silicon or chromium. Copper-bearing steels are not rust-proof or corrosion-proof, but the presence of small percentages of copper will retard attack so the corrosion rate will be only one-half or one-third that of ordinary steel under many conditions. Silicon gives steel some protection from scaling and is also used to combat certain types of acid corrosion. If full corrosion resistance is desired, however, it is necessary to have appreciable percentages of chromium in the steel.

The chromium-containing corrosion resisting steels, known popularly as stainless steels, have played an important role in popularizing alloy steels. The reasons for this are quite evident. They have all the good qualities of steel, including the ability to be strengthened, hardened, or toughened and, in addition, they are completely immune to atmospheric corrosion and to the attacks of a great many acids and salt. There are several classes of these steels, namely, the cutlery grade which contains from to 18 per cent chromium, the straight chromium hardenable engineering type of stainless having 12 per cent chromium, the austentic chromium-nickel steels and the high chromium steels containing from 17 to 28 per cent chromium.

Stainless Steel Is Metal of Thousand Uses

The austenitic stainless steel containing 18 per cent chromium and 8 per cent nickel is the type which is used so extensively in the new streamlined trains, as trim on buildings, in food processing equipment and in thousands of other applications. The chromium content is sufficient to render the steel corrosion-resistant and the nickel content high enough to make it austenitic and, consequently, both ductile and strong. It is a good example of the balanced use of alloys to provide a steel with several desired characteristics that are wholly unobtainable in carbon steels.

A discussion of a few of the many uses of stainless steels is a fitting conclusion to any discussion of alloy steels because they typify so well the way alloy steels are entering every phase of industry and commerce. In the architectural field the lofty towers of the Chrysler and Empire State buildings gleam with stainless steel as a symbol of greater applications to come. The stainless steel Zephyr trains are helping to revolutionize the railroad industry. In the food and dairy industries stainless steel has become a necessity. Other industries, such as the textile, chemical and paper and pulp are finding hundreds of applications for this metal. In the home it is appearing as table ware, furniture and kitchen equipment and utensils. A complete list of applications of this group of alloy steels alone would be numbered by thousands.

Considering the fact that the age of alloy steels has scarcely commenced—it is only several decades old—the future seems exceedingly bright. There are so many possible combinations that any property desired seems attainable. The field of alloys was hardly been scratched but the number of well organized scientific investigations in progress makes it apparent that the future of steel alloys is indeed a healthy one.

A Cross-Section of Automobile Engineering

By H. T. Woolson

Thirty years ago Mechanical Engineering dealt primarily with steam. Automotive Engineering was unknown, and whatever work was carried on along these lines was looked upon with disdain by those who were well versed in mechanics, strength of materials, thermodynamics, etc.

The tables are now turned; the older industries are profiting by the great progress made in the automotive field by intensive concentrated engineering and production efforts.

To illustrate, I might mention the metallurgical advance, with its development of a whole line of alloy steels produced to meet the exacting requirements of automotive work, without which the automobile, as we know it today, would be impossible. The development of special lubricants has been an important contribution. Railroads have adopted anti-friction bearings and pressure lubricating systems, oil impregnated and needle bearings have found their way into many industries. These, together with a host of other details, constitute the automotive industry's contribution to increased efficiency in many industries.

Successful engineering is getting out of the narrow rut in which it has travelled for so many years and is broadening to cover all phases of business. The Engineer is rapidly making a place for himself in Management. Aside from the design, development and testing of cars, he becomes interested in the purchase of all raw materials or finished parts, and the development of economic means for their conversion into finished products. Advertising, Sales and Service are included in the scope of his interests, and in view of the fact that operations must be financially successful, he is interested in the accounting angle as well.

Automobiles are designed from year to year, with due consideration to the recommendations of the Sales Department. They are based upon experience with previous models with such improvements and changes as are dictated by sales reactions, service experience, engineering developments, style trends and competition. The whole process is evolutionary in character; radical and extreme departures have often been disastrous. The price of pioneering, if the step is too great, is to high for a large corporation to undertake.

Let us consider the goal of the engineer when undertaking the creation of a new line of passenger cars: The following are some of the more prominent items for consideration.

APPEAL:—The Automobile stands alone as a mechanism hemmed in by style considerations which often take precedence over good engineering practice. Style and eye appeal are all important to create a product for which the public will readily part with its money. Mechanical excellence would have no sale beneath an ugly dress. We hope some day to reach a stage when we can say, as in the case of the areoplane "Fashioned by Function". The fact that the car is on wheels, not in the air, is largely responsible.

PERFORMANCE:—This covers a wide field of requisites, including acceleration, riding comfort, ease of operation and proper vision. We have to keep this creed constantly before us. The automobile is for the sole purpose of providing comfortable, rapid and safe conveyance. Mechanism is secondary in the eyes of the owner. He does not want to have to become interested in it. The more we can do to submerge the mechanical and hide it from the owner's sense and attention, the better we shall have succeeded as automobile engineers.

ECONOMY:—Gasoline and Oil mileage, low upkeep, high second-hand value.

DEPENDABILITY:—Safety, Roadability, Easy Starting,

PRICE:—We think our business the most competitive in the world. $15.00 to $25.00 may throw a car out of line. Engineers have to work close to the Purchasing Department.

In the engineers efforts to obtain that most important requisite, appeal, we can subdivide the work as follows: The first stage consists of numerous full size blackboard studies until the desired result is obtained. This is followed by full size clay models developed from the blackboard drawings, on which pleasing lines and other relationships are determined. A full size wood dummy is then constructed with opening doors and an interior which can be trimmed to duplicate in every way, a finished car, following the designs developed by the Interior Art Department. The final stage, of course, is a complete runnable car in steel.

Let us review the procedure in connection with Chassis Details:

In large corporations, chassis engineering is carried on by convenient groups who specialize on the various units which go to make up a car. (The Chassis includes every thing except the body and its appointments). Close co-

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EDITOR'S NOTE: *This article is an abstract of a speech given by Mr. Woolson before the Student Branch of the A.S.M.E., at a recent meeting.*

operation between groups is necessary with compromises to obtain the best overall result. The various design departments covering engines, transmissions, clutches, axles, brakes, cooling systems. etc., have Experimental Laboratories closely assoicated with them, working in close cooperation.

Let us consider the motor; the heart of the automobile. Motor development may be considered under the following heads: Economy of Operation, Endurance and Performance. Much has been accomplished of late towards improvement in life and endurance. Extensive bearing development work has been carried on with special materials such as copper lead and cadmium nickel. For the purpose of bearing testing a special machine was designed for testing connecting rod bearings. It is possible to duplicate quite closely the conditions obtained in a motor with pressure feed lubrication and controlled oil temperatures. The bearing pressure is exerted by eccentric weights on the flexible shaft, it being possible to obtain any desired pressure by the regulation of these weights.

Crankshaft development has progressed from uncounter-weighted shafts in early designs to bolted-on weights having four counter-weights on a four bearing six cyclinder engine, to the same arrangement integrally forged, finally arriving at a seven counterweighted crankshaft with integrally forged weights, representing the most modern practice, resulting in improved bearing life and smoother engine operation. (Figure 1.)

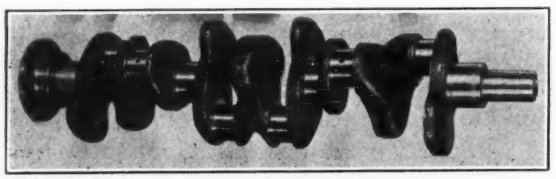

Fig. 1

Aluminum Pistons have been greatly improved. The so-called anodic coating consists of an oxidized coating on the bearing surface of the piston which has resulted in the absence of scuffing under cold starting conditions.

The exhaust valve seat inserts have resulted in marked improvement in overall motor life. The installation of these in cylinder block by contracting in dry ice and rolling in place is a very interesting development. These tool steel inserts for exhaust valves resist pounding in to a remarkable degree. The results of tests making a comparison between valves in a castiron block without inserts and one with inserts, show a very rapid reduction in tappet clearance on the former case compared with an increase of tappet clearance in the latter case, indicating

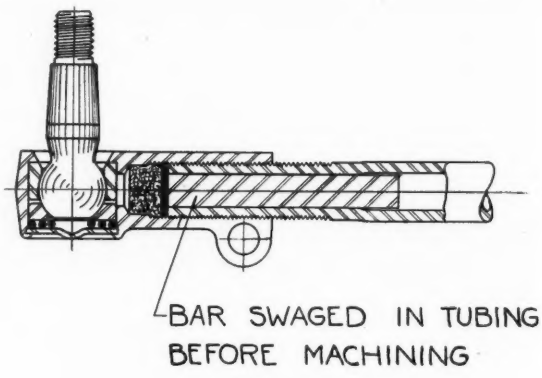

Fig. 2

great wear on the end of the valve stems than on the seats.

The Mechanical Laboratory is an extremely important engineering division covering as it does, in our set-up, all items on the car except engines, cooling systems, frames, and a few minor items. This laboratory parallels road tests on the various items with accelerated laboratory tests.

While it is important to generate foot pounds of energy for rapid acceleration, it is even more important to dissipates this energy more rapidly in the form of heat by means of the braking system. Development work on brakes is carried on without interruption year after year. Stamped drums, with poor friction surfaces, are superseded by reinforced cast iron drums, with ideal friction surfaces; a great variety of brake linings are continuously tested in an attempt to make the necessary choice between hard linings with low co-efficients of friction and long life, and soft linings with high co-efficients and shorter life. Such developments together with a host of brake refinements, have progressively led to superior brakes.

One of the most baffling problems has been the development of cylinders for hydraulic brakes, rubber cups for brake pistons and the development of brake fluid which will give satisfaction at the Equator as well as the North Pole.

A recent trouble experienced in Northern Canada, was the hardening of the cups at low temperatures which was overcome by the adoption of an improved grade of rubber together with a stamped expander.

Another difficulty arose due to the corrosive action of certain brake fluids on cast aluminum. These troubles were overcome by the use of pistons made from duralumin.

When the "Airflow" cars were first brought out in which the engine was pushed far forward (a practice, incidentally, which all modern cars have since adopted) we immediately made a lot of trouble for ourselves length-

ening the propeller shaft by about 10". This length was considered beyond the limits of good practice. The problem was not to find a shaft strong enough, but one smooth and free from out-of-balance vibration.

Some difficulty with fatigue life of steering tie rods resulted in a test with an inserted plug as shown in figure 2. Much to our surprise, the fatigue life was increased ten times. I believe this might be a good problem for students to figure why such should be the case when the section modulus is increased only by a very slight amount.

A recent improvement in Water Pump designs consists of the introduction of the water seal within the housing. This has given remarkable results compared to the conventional outside stuffing box. It has kept the water out of the bearings and the oil in.

In recent years automobile engineers have become more and more weight conscious. Acceleration has also become a valuable sales asset. There are two ways of improvement in this direction; first, by increasing the torque and horsepower of the motor by increasing its size, and second, by reducing the weight of various car units retaining the same motor size.

The former method was quite commonly employed some years ago and is still often resorted to. This method, however, does not always result in direct gain as part of the increase in power must be used to accelerate the extra weight of units required by the power increase. The second method is more direct, logical and scientific. If any structure or mechanism is critically examined, there will be found to be considerable dead material not working to anywhere near its capacity.

I have termed this material "Lazy Pounds", and our object is to remove, insofar as possible, these lazy pounds, and approach, on our automobiles, more nearly the ideals as exemplified in aircraft construction in which its very life depends on having every pound pull its load.

Cost also comes into consideration as every pound has to be purchased, and other things being equal, cost is, in direct proportion, to weight. Think of what 100 pounds off a high production car means in material cost reduction and tonage reduction for handling.

In the past, the majority of automobiles used a rigid forged "I" beam for front axles, and as unsprung weight this is very desirable. It became essential that a lighter beam be designed. Therefore, a very satisfactory design was produced made from seamless steel tubing, with spools pressed into the tubing and welded. This tubular beam is fifteen to seventeen pounds lighter than the forged "I" beam, and added much to brake torsional value.

Figure 3 shows both cast iron and steel constructed

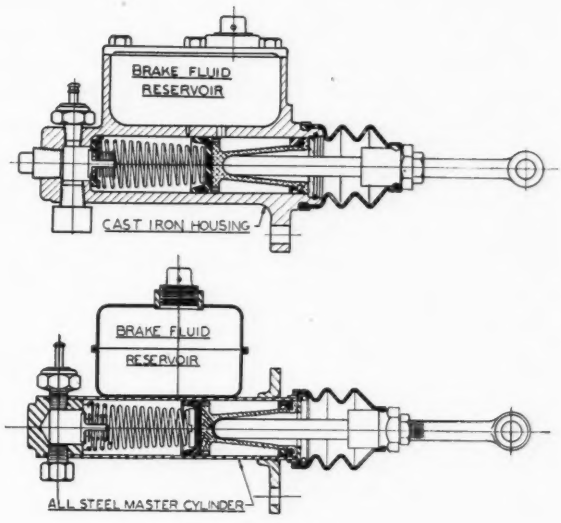

Fig. 3

master cylinders for the brake system. The cast iron master cylinder has a brake fluid reservoir which has a cover, gasket, lock washers, screws and numerous machine parts. The casting must be cleaned thoroughly to be free from sand and grit. On the steel master cylinder a very light metal is used. The function of this fluid reservoir is simply a gravity feed for the brake fluid into the cylinder proper. A tomato can would answer the purpose, whereas, on the cast master cylinder, the strength is much greater than required. The cast master cylinder also has complicated machine operations, whereas, the master cylinder shown is made of steel tubing and steel stamped parts, hydrogen welded. This construction is cheaper and saves approximately five pounds in weight.

Careful consideration of all the phases in connection with cooling is a very important engineering item. This covers the design of radiators, involving the flow of air through radiator grilles, fan design and also the water circulation through pump, cylinder block and distributor pipe to each of the cylinders incorporating a by-pass thermostat for temperature control

A method for testing chassis frames was developed consisting of the application of loads with the distribution similar to that existing on an actual car. Frame twist is obtained with the so-called three wheel loading in which the support is removed at the fourth wheel. By this method frames can be compared relatively and improvements in design can be readily checked. Similar tests are also conducted with a complete frame and body assembly. Valuable data has been obtained toward obtaining greater car rigidity by improved designs guided by such a test program.

The Digestion of Sewage Sludge

By Weston Gavett C.E. '11, M.C.E. '12

Sludge digestion is probably the oldest and still the most universally used basic process in sewage treatment. The term describes the rotting of sewage solids in a tank from which air is excluded.

The fact that organic matter will break down in the absence of air was known as long ago as 1860 when the Mouras scavenger, in effect a cesspool, was introduced in France and largely used. The Paris sewers were originally intended for storm water and tank treatment was required before sanitary sewage could be discharged into the City sewers. For a time there was great interest in the destruction of animal and vegetable matter by digestion. An animal placed in a demonstration tank would be cleaned to the bone in a few weeks. These demonstrations encouraged the belief that solid organic matter was completely removed by digestion. This belief was strengthened by the claims for the Cameron Septic Tank which was patented in the United States in 1899. The process was similar in principle to the Mouras and other tanks constructed here and abroad. Ballyhoo was as successful then as today, however, and the "Septic Tank" was generally accepted as a marvellous new process. Large fees were demanded of users of septic tanks by the holders of the patents and as a result there was extensive litigation. The company was successful for a time and obtained a decision against Saratoga and settlements from other municipalities. When action was brought against the United States Government based on alleged infringement at a Soldier's Home in Johnson City and other institutional plants, the court held that the patents were not infringed and septic tanks were then free for general use. Clyde Potts, '01 was retained by the Department of Justice to prepare the engineering defense in this case.

Septic tanks were standard practice for a number of years and many are still in successful service. With proper operation, excellent results can be obtained from well designed septic tanks. The combination of sewage sedimentation and sludge digestion in the same tank gave rise to difficulties that paved way for the Imhoff tank which was patented in the United States in 1910. In the septic tank the occasional overturning of sludge and the lifting of sludge particles by gas evolved caused uncertainty of operation with poor effluent at times. Odor caused difficulty at some plants and it is curious in these days when sewage plants are constructed in districts surrounded by high class residences, to read in some of the older textbooks that odor may be noticed from ¼ to ¾ of a mile from the septic tank. In the Travis tank and the subsequent Imhoff tank, sludge was separated from the settling sewage by baffles. The effort to separate the two distinct processes of sewage clarification and sludge digestion has been carried to its logical conclusion by the provision of separate tanks for the two processes. An early example was the separate sedimentation and sludge digestion tanks at Baltimore, Md., constructed in 1902-12. Separate sludge digestion has many advantages. Each tank may be designed to better advantage for its special function as a separate unit. Sludge removal apparatus may be more readily used in separate sedimentation tanks. Deep cuts required for Imhoff tanks are not required for separate sludge digestion. Separate sludge digestion tanks may be heated to the optimum temperature for digestion and summer conditions maintained throughout the year. This makes for smaller tank capacities. In the combined tanks sufficient sludge capacity was needed to store the sludge over the winter months when low temperatures slowed down or completely arrested the biological digestion process. Heating of sludge in combined tanks was not possible. The collection and utilization of gas is facilitated by the use of separate sludge digestion tanks.

A serious difficulty with septic tanks and open separate sludge digestion tanks was the formation of scum. Fat or gas-buoyed sludge particles accumulate at the water surface and are pushed up and dried. In some tanks practically all of the solids would collect at the top of the tank rather than at the bottom. The scum layer would not be digested or would be partially digested with very offensive odor. Clyde Potts in 1915 installed a sedimentation tank for South Bound Brook, New Jersey, so arranged that the water level could be maintained above the bottom of the concrete roof. This simple and practical scheme prevented drying out of the scum. Solids lifted to the top remained submerged and would continue to digest. This principle of the "suppressed roof" while not patented and little publicized was an important advance in tank design. It has since been used in a number of designs for sedimentation and sludge digestion tanks. The separate sludge digestion tanks of the plant at Boonton constructed by Jersey City in 1924 to treat the sewage of municipalities above the Jersey City Reservoir was of the suppressed roof type and also included the collection of gas.

John R. Downes in 1929 patented another improvement for separate sludge digestion tanks, the floating cover, in which the roof floats on the surface of the sludge. This type has many points of merit and has been largely used.

Gould describes a somewhat different type of cover designed by Fuertes for Lynbrook, N. J., in which the gas is allowed to collect under a cover similar to a gas holder.

The writer designed a fixed cover tank which was patented in 1922 to retain the opportunity to use it. This tank is of the fixed cover type with provision for collection of gas under the upper part of the tank. The purpose was the utilization of the pressure which the evolution of gas is capable of creating, to eject the supernatant

liquor or the sludge, making possible the discharge of supernatant liquor at a low constant rate. The space provided by the gas formation is used to receive fresh sludge thus preventing the discharge of supernatant liquor at a high rate when fresh sludge is added to the tank. The supernatant liquor may have a high organic content and if discharged to the treatment process at a high rate may upset the operation of the treatment.

The knowledge of the fundamental scientific principles of sludge digestion has greately increased during the last 20 years. Much early research on sludge digestion was done by the New Jersey Sewage Experiment station which was established after work by Dr. Headlee of Rutgers on the sprinkling filter fly at Plainfield, through the cooperation of Rutgers University, the New Jersey State Department of Health and the New Jersey Sewage Works Association. Credit is due to John R. Downes who suggested practical lines of research during the early days of the Station. The subsequent work of Dr. Rudolfs and his associates is well known.

Considerable general information on sludge digestion had been known to engineers and operators such as the types of sludge digestion, the increase of digestion activity with the temperature; the beneficial effect of lime; the practical values for tank capacity had been pretty well determined by experience. These general observations with many other important data have been accurately determined and charted by research laboratories so there is now an abundance of authentic basic information available for the design and operation of sludge digestion tanks. Sludge digestion, formerly dependent on the knowledge, experience and judgment of the operator is now a more exact science and is so conducted under laboratory control at many plants.

J. D. Watson in 1921 described the successful installation and operation of a 34 b.h.p. gas engine with sludge gas at Birmingham, England. He mentioned a small engine driven by gas in Bombay, India in 1907 and another engine operated in Australia but pointed out that the Birmingham demonstration showed that "it is not necessary to possess the climate of India or Australia to obtain power gas from sewage."

In a paper before the New Jersey Sewage Works Association in 1925 the writer mentioned the use of gas as follows:

"L. A. B. Wade, of the Dept. of Public Works of New South Wales reported using gas from the Parramatta septic tanks to generate lighting current using a gas engine in 1911.

Charles C. Homon described in 1916, the collecting and utilization of gas from the Imhoff tanks in Atlanta, Ga. The nature of the gas evolved by sludge digestion has long been known, but American engineers have apparently neglected the possibilities for its utilization in the design of plants, so it has been allowed to bubble up and make foam and waste to the air.

C. E. Leonard described the elimination of odors by burning the gas at Austin, Texas, in 1922.

At the present Boonton plant, designed in 1922, gas collectors are provided to collect all gas from the sludge digestion tanks. Gas may be burned in the greenhouses and piping is provided so that the digesting sludge may be warmed. In a proposed plant, designed last year. of the activated sludge type, sludge will be digested and gas used to run a gas engine and generate power. The gas power can be used at times of peak load on the municipal plant. It is estimated that not less than 15% of the power required for activation will be obtained from the gas, and it is expected this volume will be greatly exceeded. The digestion tanks are designed not only to digest sludge but to serve as efficient gas generators as well, and the heat from the engine exhaust and cooling water will be used to warm the sludge pumped to the tanks. Dr. Imhoff in a paper published in 1923 describes the use of gas from Imhoff tanks, how its heating value may be increased by allowing the CO_2 to be absorbed in the tanks, and other practical information on its collection. It is a curious thing that our friends on the other side seem more apt at converting new ideas or results of research to practical use than we practical Americans—witness the development of the activated sludge process.

It is interesting to consider the cash value of the gas. Dr. Imhoff gives the amount of gas to be expected as 0.3 cubic foot per capita daily. Published data in this country, and experiments give higher values.

Assuming 0.4 cu. ft. per capita daily of gas with 80% methane. One million gallons (10,000 people) would give 4,000 cu. ft. of gas. From data furnished by Mr. Coly, M.E., on the Winton engine, 1,000 cu. ft. of this gas per hour would furnish about 34 K.W. At 3½ cents per K.W.H. 1,000 cu. ft. of gas is worth $1.19 and 4,000 cu. ft. (the yield per million gallons would be worth $4.76.

Gas may be used for lighting and household use as at Atlanta, for warming the contents of separate sludge digestion and municipal use as described by Dr. Imhoff, and for power as described by Wade. It also would seem logical to use it for sludge drying."

The above is quoted at some length as the observations are still pertinent and the practicability of the use of gas for power has been confirmed by many recent installations. Recent literature has intended to overlook some of the pioneer work in the utilization of gas for power. In this country Downes used gas to heat digestion tanks at Plainfield in 1925 and at the same time ran a small gas engine connected with blower. The first permanent installation in the country was probably that at Charlotte, N. C., in 1928 by W. A. Piett which included a 225 and 75 H.P. engine. The Rockville Centre plant described by the writer in previous reference was designed in 1924 by Clyde Potts but was not constructed until 1929. The results obtained during the first year of operation of the gas engines were described in 1931. The methane content of 80% estimated in 1924 was high for gas from separate sludge tanks, but the 1924 estimates of the saving effected by the engines was exceeded by actual performance. A 170 H.P. engine direct connected to 90 KVA generator was included in the Morristown activated sludge plant constructed in 1930-31. This engine is equipped for either gasolene or gas as were the engines at Rockville Centre and other plants. The Morristown gas engine driven generator is large enough to carry the entire plant load. This arrangement has the advantage that the engine operation is not dependent upon the supply of gas in case of power failure or if it is desired to cut

off the plant from the outside power supply to obtain off-peak power rates. The ability to operate the engine on either sludge gas or gasoline has cash value.

A very thorough analysis of the operation and saving effected by the use of sludge gas for power was published by Walraven in 1933. He shows as a result of careful tests that 81.7% of the heat value in the gas was recovered as useful work or went into the digestion tank heating system. He gives 17 to 20 cubic feet of gas per H.P. hour of work done as used by the engines. Results at Rockville Centre reported by the writer in 1931 indicated gas consumption of 20 to 30 cubic feet of gas per hour per H.P. work done and the power available of 15 to 20 H.P. per million gallons of sewage flow.

Sludge digestion is a process that may be economically used in many plants. The design of a plant is dependent on a number of factors determined by the particular conditions at the locality. The selection of the best type of plant requires the careful consideration of an engineer qualified by adequate experience in sewage treatment, preferably one who is not connected with commercial sewage firms. Some of the advantages of sludge digestion to be considered in choosing a method of sludge treatment are as follows. Sludge tanks act as storage tanks making it unnecessary to remove sludge daily. Collection and utilization of gas will partially or completely offset the cost of the tanks. Digestion of sludge can be accomplished without nuisance and the utilization of gas prevents nuisance from this source. Well digested sludge is inodorus and is an excellent soil dressing. While analyses show it to be a low grade fertilizer its use indicates a value greater than the shown by analysis. Beautiful lawns may be made from a barren sandy soil dressed with digested sludge. It is in demand for treatment of golf courses and is used at nurseries and greenhouses. While not recommended for uncooked vegetables the results of investigators show that there is little danger of pathogenic bacteria surviving sludge digestion. The introduction of sludge grinders has increased the desirability and saleability of digested sludge as a soil dressing.

Sludge digestion greatly reduces the volume of sludge to be handled. This is due partly to the reduction in actual organic content and to a great extent to the thickening of the sludge due to its lower water content. The sludge weight is inversely proportional to the dry solid content, so a 90% moisture sludge will have half the weight of a 95% moisture sludge, both having the same weight of dry solids. This reduction of volume is of advantage no matter what may be the final disposition. For example in the crudest method of sludge, barging to sea, the cost is proportional to the tonnage of sludge removed. If digested sludge rather than fresh solids are removed the quantity to be barged and the resulting cost may be greatly reduced.

Where sludge is to be dewatered on vacuum filters a large saving results if the sludge is digested. In addition to the smaller volume to be dewatered digested sludge may be filtered at a higher rate. One filter company estimates a rate of 6 pounds dry solids per square foot of filter surface per hour for digested sludge against 4 pounds per dry solids per square foot per hour for fresh solids. While these rates can be exceeded for both types of sludge they indicate the fact that digested sludge is more readily dewatered by vacuum filters than fresh sludge.

Even where incineration is contemplated it is expected that sludge digestion while destroying some of the calorific value of the sludge will prove economical in many cases because of the advantages of storage provided, smaller volume of sludge to handle, the utilization of gas and the better filterability of the sludge. In a locality where there is a lean or sandy soil the incineration of sludge appears to be an economical waste.

Work on the acceleration of sludge digestion by increasing the temperature carried by Dr. Heukelekian of the New Jersey Sewage Experiment Station into the Thermophilic range of 120 deg. F. and above. His experiments showed that the digestion rate was greatly accelerated. The considerable saving that would result from reduction in tank size, while offset to some extent by the special design needed for high temperature digestion with special reference to heat conservation, indicate great possibilities in high temperature digestion. This process appears to be privately controlled, however, at present which may tend to retard the development of the process.

As long as the patent office continues to issue patents on processes or devices that have been previously used, patented, described or on obvious combinations of well known processes, the question of patents will be a serious one for the Engineer and an expensive problem for municipalities. George W. Fuller in his "Sewage Disposal" published in 1912 spoke of the patent situation at that time as follows: "judging from experience in the field of water purification the situation is a trying one from various viewpoints. With water filters, owners of various patents have been prolific in their criticism of the work of engineers and other patent owners and have done more or less harm to the advance of that branch of sanitary work." The situation today is even more acute than described by Fuller in 1912. No matter how worthless a patent may be it is as valuable as a machine-gun in the hands of a company ardently desiring sales. It is quite customary to provide a clause in specifications that the contractor shall pay for all patients, licenses and fees. If the plant he has contracted to build has been designed by an engineer and not by an apparatus company the contractor is apt to receive word that he is infringing patents of the "X" Company and will be sued. However should he desire to use their apparatus at a greater cost he will be relieved of all liability. For the contractor or municipality to contest the validity of the patent in the courts would probably cost more than the total amount of the contract. Some Engineers have chosen the easiest way and are designing proprietory plants. The few who prefer to keep their professional independence are finding it very difficult sledding indeed.

CORNELL ENGINEERS

Henry Neely Ogden

By Sidney Davidson, M.E. '36

Before it is possible to appreciate the position which Professor H. N. Ogden, Professor of Sanitary Engineering in the School of Civil Engineering, occupies at Cornell, it is necessary to go back to the time when he was a student and Estevan Antonio Fuertes was Dean of the College of Civil Engineering. This is because Professor Ogden, like many other Cornell men, is indebted to Fuertes for his highest inspirations and ideals in engineering. He was closely associated with Fuertes for many years and in 1902, succeeded him as Head of the Department of Sanitary Engineering.

Professor Ogden was born in Dexter, Maine, on April 30, 1868. His father was a clergyman and a graduate of Hobart College. He is a member of the Ogden Family which is descended from John Ogden, an Englishman who emigrated to Long Island in 1640 and who finally settled in Elizabethtown, New Jersey, in 1664. Formal education began for him at the Episcopal Academy in Philadelphia where he spent two years. He next entered Cheltenham Academy, near Philadelphia, where he undertook classical studies in peparation for college. At the end of two years he was graduated as the outstanding student of the class. In 1885 he entered the College of Civil Engineering at Cornell and did commendable work in his studies. He graduated with the degree of C.E. in 1889.

After graduation, he did not intend to teach but did so only after Professor Fuertes had asked him to do so. In 1891 he left Cornell and took a position as computer and transitman on the Chicago Drainage Canal, following which he undertook a private practice at Norfolk, Va. Six months later he became City Engineer for Deering, Me. In the fall of 1893, he was elected to the position of instructor of Sanitary Engineering at Cornell. In 1898, he rose to the position of Assistant Professor and in 1908, became a Professor of Sanitary Engineering.

In his relations with students, Professor Ogden has always tried to have enough friendly relations with them to make his work both inspiring and educational. For this reason he values his membership in Pyramid.

To him, classroom work plays a small part in determining success. A practice of his has been to take the men in his sanitation courses on inspection trips in the vicinity of Ithaca after they have obtained a grasp of the subject. He does this because he believes that a person can not get the proper aspect of things merely from studying a book, but like Fuertes, believes that anything which gets into a text-book is at least ten years old. He always impresses these facts upon his students and many of them will remember him for this.

The most important traits that Professor Ogden attempts to instill in his students are the distinguishing characeristics of a big engineer, vision and knowledge—to know where best to place a bridge as well as to be able to design it. Thus in presenting his courses in sanitary engineering, he has always offered along with them a course in municipal engineering in order to increase the breadth of the subject. The latter includes a study of the relationships that exist between the practicing municipal engineer and the various state and city commissions and other organizations.

As a practising engineer, Professor Ogden has had a varied and successful career which has aided him greatly in his teaching. From 1893 to 1895, he designed and constructed the entire sewerage system for the city of Ithaca. He has also frequently acted in the capacity of consulting engineer in the designing and building of sewerage systems in cities in the Eastern and mid-Western States. In 1888, in 1896 and in 1910, he visited England and Germany to study and inspect the construction and operation of sewerage works. Between 1915 and 1916, he studied the sanitary condition of Akron, Ohio, and perfected a reorganization of the Sanitary Department of that city.

On the Cornell Campus, Professor Ogden's ability has been indelibly recorded. First is the stone-arch span over Cascadilla Gorge, designed and erected by him from 1895 to 1896. The second project consisted of the extensive leveling and grading of Upper and Lower Alumni Fields. It is interesting to note that the small brook which runs past Sage is merely the drainage from these fields.

In 1906, Professor Ogden began his public health

(*Continued on page one hundred seventy-six*)

THE CORNELL ENGINEER

PUBLISHED MONTHLY DURING THE COLLEGE YEAR

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✣ EDITORIALS ✣

THE NEW BOARD

The Cornell Engineer takes pleasure in announcing the Publication Board for the coming year and extends congratulations and good wishes to the following men in their new positions.

Editor-in-Chief, Preston Day Carter, M.E., Detroit, Michigan.

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SWAN SONG

With this issue, the Senior Board of the Cornell Engineer turns over the reins to the newly elected Juniors listed above. To them will fall the task of editing and managing the magazine during its second year on the campus.

When the merger of the two Cornell engineering magazines was being discussed, and even after its culmination, there were many who doubted the ability of a small publication to cover all three branches of engineering. We have endeavored to meet this difficulty by publishing not only articles on all engineering fields but also articles of general interest to all engineers. We realize that their is still plenty of room for improvement, and it is our hope that this first year's experience will provide a framework upon which succeeding boards will add to and improve.

We should also counsel our successors in passing that they keep in mind the primary purpose of the Cornell Engineer; i.e., to further the best interests of the College of Engineering at Cornell. The immediate objective in forming the combined magazine was to help produce a more coordinated and unified College from the three schools. We believe that the Engineer has done much to promote this unity, and that it will continue with even greater success in the future. However, our activity has not been confined to the campus alone. Through our connection with the Cornell Society of Engineers we have begun to forge what we hope will be a more intimate link between students, faculty, and alumni.

In conclusion, may we express our deep appreciation for the support, advice, and assistance given us by the students, faculty, and the Cornell Society of Engineers. The first year of such an enterprise as this is always a trying one, and the backing of these groups had no small effect in lightening our task. We can think of no more appropriate blessing with which to bequeath our successors than this good-will.

Take it away, '37!

LIGHT FOR THE FARMER

There is at the present time considerable attention being paid to the problem of rural electrification. As is usual with such problems, final action is in the hands of a group of men who are utterly unqualified, either by training or experience, to pass judgment on an issue which involves so many problems of a technical and economic nature. A short time ago, there was considerable agitation in the United States Senate for a bill which would provide a billion dollar program of rural electrification over the next ten years. That such a program should be proposed is entirely natural, when we consider some of the other grandiose schemes which have been attempted by the administration in the last few years.

In the minds of most people, there is little question that it would be a desirable thing to have a supply of cheap electricity available to each and every farmer in the country. But so far, there has been no way devised which can bring this about, unless the taxpayers of the country are to foot the bill.

A great many dreamers envision a cast network of distribution lines, covering the country, and carrying power generated at colossal government-owned hydroelectric developments. Such a program would be entirely unsound from an economic viewpoint however feasible it might be from the practical side. The fixed charges on such a stupendous investment would raise the cost of the power generated therefrom to such a level that no one could possibly afford to use it except when absolutely necessary. This same would hold true for any other of power generation at central stations, and distributing it over a wide area. The fixed charges on the equipment necessary to distribute the power, especially in the sparsely settled districts, would be so high as to render the use of electricity impractical.

A much more practical plan would be one in which each individual farm, or possibly a group of farms close together, would have their own generating plant, driven by either a gasoline or a Diesel engine, to generate power for lighting and small machinery, using, as is common now, gasolene or kerosene engines for the major power requirements. Such a system would not have quite the convenience that a large system would offer, but the investment cost per kilowatt hour actually used would be a great deal less.

Such a program could not, of course, be carried out without assistance from some source. There are few farmers who can afford to buy outright the generating equipment necessary to supply even their own needs. A governmental subsidy, in the form of long term loans, is probably the best way of financing such a program. Since governmental subsidies seem to be very popular these days, there is no reason why there should not be one to bring the blessings of electric power to the farmers. If it were properly organized and handled by competent men, such a program would not result in a net cost to the taxpayers as a whole.

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SHORT WAVE RADIO

In the recent March floods, the worth of the amateur radio enthusiast was again proven. Had it not been for them there are a great many towns in Pennsylvania and Southern New York that would have had no communication with the outer world. It was the "hams" who stuck by their sets for forty-eight hours at a time. They broadcast directions and the whereabouts of food and medical supplies to the men working to relieve suffering people and in every way helped to save the lives of hundreds of people.

Amateur radio is a complete field in itself and amateur transmissions make up the majority of the things heard on the short wave bands. A great many colleges have seen fit to encourage the growth of this field by delveloping and maintaining amateur radio stations under the direction of the college. It seems too bad that a university the size of Cornell should not be adding its bit toward this growth. The reputation of Cornell as an engineering college is excellent and yet with all this reputation they are letting a thing, which is in every sense engineering and which would undoubtedly draw students, be developed by other institutions.

It can of course, be said that Cornell does have a radio station. That is granted. WESG is a very fine station, but the fact remains that it is a long wave station belonging to a national network and the only thing the students of Cornell have to do with it is to provide the talent which it broadcasts. Do not let it be inferred that the Radio Guild is not a fine thing, but men who are interested in the technical side of radio do not have much chance. All programs which go out over WESG have to be put on the air by licensed operators. From the engineering point of view there is no kick to watching someone else put the program on the air. Then too there is not much chance to experiment with a station like WESG.

Why can't Cornell have an amateur station, built under supervision of the School of Electrical Engineering and run by the students who are interested in it? Or, if sufficient interest were developed, a club could operate a "ham" transmitter. Another possibility is the Signal Corps. An amateur station was once set up there, and would still be serviceable, even though slightly antiquated. (This possibility will be objected to by non-militarists, however.) In all events it would acord plenty of opportunity for experimenting and gathering experience in the technical side of radio.

COLLEGE

ENGINEERING SHOW

On Cornell Day the School of Civil, Electrical and Mechanical Engineering will hold their Second Annual Engineering Exhibit for the benefit of visiting subfreshmen. Alumni have been invited to a gathering with members of the faculty on Friday night and a trip through the exhibits. The show, which was held last year exclusively for Cornellians and guests, is being opened this year to the general public.

The School of Mechanical Engineering will show in their Mechanical Laboratory a Compound Corliss Steam Engine, an air compressor and an automotive engine test. In the machine shops there will be exhibits in metallurgy, machine design, and aeronautics; the latter consisting of a wind tunnel. There will also be kinematic models, steam engine and turbine models, an automotive exhibit and an exhibit of special slide rules.

For the School of Civil Engineering the various departments will present exhibits covering their field. The Department of Hydraulic Engineering will demonstrate by models the latest methods of flood control by the use of hydraulic structures. The Department of Sructural Engineering will show the photo-elastic method of stress analysis and stresses in trusses will be demonstrated by the use of a truss provided with extensometers. Tests will be made by the Department of Engineering Materials on the strength of concrete, steel building materials, and riveted joints. The new Department of Soil Mechanics will show the characteristics of soil by tests and also demonstrate the percolation paths of water under dams by the electric analogy method. In addition there will be exhibits by the Department of Sanitary Engineering of the methods of testing and treating water supplies and sewage, and an exhibition of types of surveying equipment from past to present by the Department of Surveying.

The School of Electrical Engineering will hold their regular show with many new and interesting exhibits added to that of last year. L. W. Collings '36 is in charge of the E.E. show; S. Davidson '36 is in charge of the M.E. show, and Art Glasser '36 and J. McManus '36 are in charge of the C.E. show.

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TAU BETA PI HAS INFORMAL DINNER

Old and new members of Tau Beta Pi became acquainted at a dinner meeting in Willard Straight Hall on Thursday, April 9. At that time, the juniors and seniors who had been elected to membership at the previous meeting were introduced to those of the older members not alrady acquainted with them.

Professor S. C. Hollister, Director of the School of Civil Engineering, was the speaker for the evening.

The informal and formal initiation of these new members, which will take place on two successive nights, is now being arranged and will be held in the near future.

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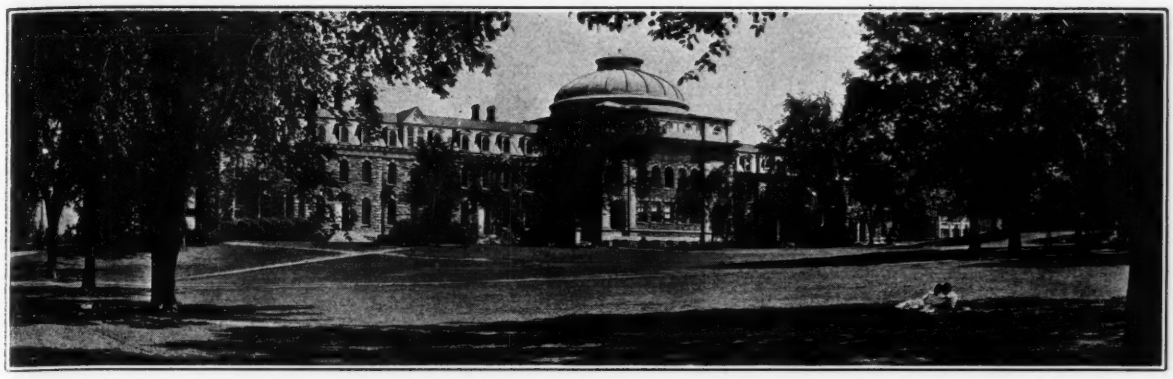
A.S.C.E. TO HOLD REGIONAL ENGINEERING CONFERENCE AT CORNELL ON MAY 9

On May 9, members of local sections and student chapters of the A.S.C.E. will gather in Ithaca for an all day conference. Delegates are expected from the following sections: Buffalo, Rochester, Syracuse, and Ithaca; and from the following student chapters: Clarkson, Syracuse, Union, Rensselaer, Lehigh, Penn State, and Bucknell.

The main purpose of the meeting is the discussion of matters pertaining to the society, especially those concerning the younger men in the society and the question of forming a junior organization. The morning session will be a combined meeting of both the section and student chapter delegates, but the afternoon session will be divided into two groups.

A banquet will be held in the evening to which all Civil Engineers are invited. Daniel W. Mead C.E. '84, President of the A.S.C.E., will be the chief speaker of the evening.



NOTES

A.I.E.E.

Mr. Lee McCann, of Stromberg Carlson, was the guest speaker at the last meeting of the Student branch of the A.I.E.E. His topic was "High Fidelity Radio". He first gave an interesting lecture, illustrated by lantern slides, on what high fidelity radio really was. The great difference between the tonal quality of some of the cheaper radios, and of a genuine high fidelity radio was vividly pointed out. The low quality sets often do not reproduce sounds above 3500 cycles per second, and a majority do not go above 4500 c.p.c. But Mr. McCann showed that tones of higher frequencies than these were necessary for true high fidelity.

Similarly, the lower notes were attenuated by low quality radios. This effect, is, however, due more to accoustical causes, whereas, in the former case, circuit constants may be at fault. The remedies is the use of large baffles. Some people went to extremes to get large baffle area, one man building an addition to his house so that he could use the ceiling of it for a baffle. Such means are unnecessary, with the sound labyrinth. The sound labyrinth is really a broadly tuned low frequency acoustical resonant chamber, which enables good response down to 35 c.p.s. This seems to furnish the most satisfactory solution to the problem.

By the use of some really elegant pieces of apparatus which Mr. McCann brought with him, the audience was shown the difference between ordinary reproduction and high fidelity. The apparatus consisted of one of Stromberg's latest commercial models, complete with sound labyrinth, a filter, to give sharp cutoff at definite frequencies, and various phonograph pickup and microphone equipment.

The students were also given the opportunity of hearing the familar voice of Professor Strong (making the usual type of pun) through the high fidelity equipment. The meeting was well attended, and the audience appeared interested in the discussion.

A.S.C.E. MEETING

The local branch of the student A.S.C.E. held its first meeting of the second term on Wednesday, March 25 in West Sibley. President Glasser opened the meeting with the announcement of a civil engineering show to be held at the same time as the electrical engineering show. Following this Prof. F. A. Barnes showed some very interesting motion pictures of the handling of the dirt and gravel used in the construction of the Grand Coulee Dam. These pictures followed the dirt and gravel from its excavation several miles from the actual work, along endless conveyor belts extending in places for more than a mile, through various grader and separators, and finally into use in making fills or into huge storage piles near the construction work.

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ETA KAPPA NU

Eta Kappa Nu, national honorary society in Electrical Engineering, recently elected the following Juniors to membership: R. R. Gay, C. E. Greif, F. A. Parsons, T. C. Rehm, H. E. Stephenson, and N. E. Wilson.

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STUDENT A.S.M.E.

On Wednesday, March 18, Mr. Francis Hodgkinson, consulting mechanical engineer for the Westinghouse Electric and Manufacturing Co., addressed a public meeting of the student branch of the A.S.M.E. on the subject of "High Pressure Boilers and the Application of High Pressure Steam." After discussing some of the economical and technical problem of high pressure boilers, Mr. Hodgkinson discussed some of the types of high pressure boilers in favor here and abroad and stated some of their practical advantages and disadvantages. He illustrated his lecture with slides of the various types of boilers. After the talk the meeting was thrown open to questions and discussion.

CORNELL SOCIETY of ENGINEERS

EDWARD C. M. STAHL '13, PRESIDENT

J. D. TULLER '09, VICE PRESIDENT — S. C. HOLLISTER, VICE PRESIDENT

EDWARD B. KIRBY '25, RECORDING SECRETARY — JOHN P. SYME '26, SECRETARY AND TREASURER

"The objects of this Society are to promote the Welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Column

Fellow Members

"Cornell Day" will again be celebrated on May 16. Just what is it? And where do we fit in? This day is now an annual event designed to acquaint prospective students with the aims and objects of Cornell University and with the details of the various courses in the different colleges. The University is on parade and the college of engineering participates with spectatcular exhibits. As this is the third year for Cornell Day considerable experience in its organization and choosing of prospective candidates has been accumulated so that this year a very well worked out plan for selecting the visitors has been developed and more active participation by alumni than ever before in obtaining prospective freshmen is expected. In order to properly acknowledge alumni participation the campus fraternities have agreed to reserve one-half of their accommodations for boys who are brought wholly through alumni efforts. Last year provision was made by the fraternities to handle alumni prospects in the ratio of one-third to two-thirds student invited guests.

The general scheme for carrying out the program is under the chairmanship of Ray S. Ashbery '25 who is coordinating the efforts of various Cornell Club committees, independent committees and the undergraduate committee. Another important unit to accelerate the work of alumni this year is an executive committee appointed by William J. Thorne ME '11, Chairman of the Cornell Alumni Corporation Committee on relations with secondary schools, representing the fourteen districts from which boys will be brought to Ithaca The Engineers in this group are Clarence J. Pope '10, Newark, N. J.; G. Gilson Terriberry '15, New York City; Howard T. Critchlow '10, Trenton, N. J.; Alfred H. Hutchinson '09, Chicago, Ill.; John S. Gorrell '05, Washington, D. C.; Prentice Cushing '05, Albany, N. Y.; Thomas F. Crawford '06, Philadelphia, Pa.; Eugene C. Batchelar '02, Pittsburgh, Pa.; Frank Nitzberg '22, Detroit, Michigan.

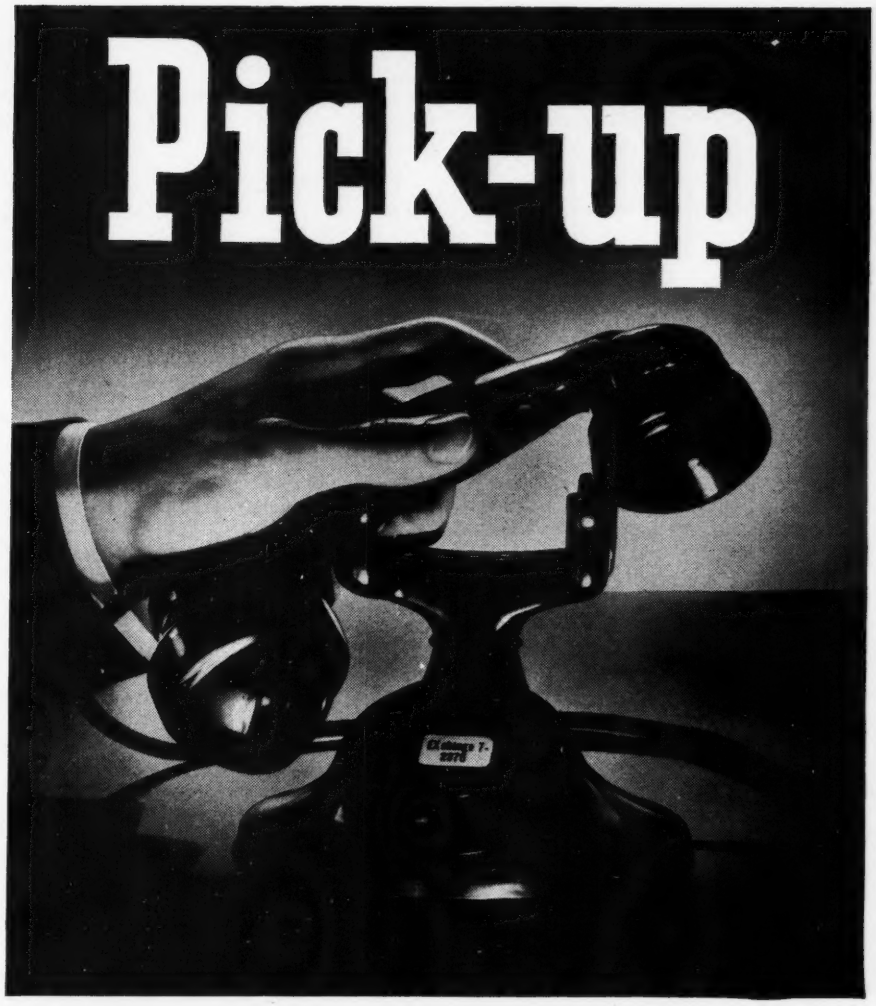
In order to make the results effective a very careful investigation of each proposed candidate is being made by either a local Cornell club or by an alumnus appointed for that purpose. No one should be proposed who is not scholastically qualified nor financially able to enter the university should he wish to do so.

The names of prospective students should be submitted to Ray S. Ashbery at Ithaca. This is necessary in order that the required investigation be made and also because the various districts will be allotted quota in order to limit the total number of visitors to the sleeping and other entertainment facilities available.

The program at Ithaca will include the track meet with the University of Pennsylvania, special exhibits in the various colleges with tours of inspection about the campus, entertainment for meals and overnight at fraternity houses, and several gatherings of all the guests and their undergraduate and alumni hosts. Last year 250 of the 610 guests showed an active interest in the engineering college and 135 actually registered in engineering.

To stimulate interest in and for the engineering college at Cornell among prospective students is a very real obligation on the part of our members. It is not merely a momentary obligation but one which should be continuing. Another phase of this situation in which the alumnus can be very helpful even though he may not for the moment be in a position to recommend a student is to provide automobile transportation In connection with this service the alumni have formed a "chauffeurs' Club" and the members of this club have found Cornell Day to be a very pleasant and profitable outing, giving opportunity to visit with each other, to again see the university in action, to be entertained moderately, and best of all to have the satisfaction of contributing a most useful and helpful task for Cornell. The plan contemplates having the boys there by Friday evening if possible and staying over until Sunday. Professor Diederichs '97 is Faculty Advisor to the undergraduate executive committee and we graduates certainly want to give him our wholehearted support.

(*Continued on page one hundred seventy-four*)



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Professor Diederichs is a widely recognized leader in Collegiate affairs. Another recent honor has been conferred upon him which further emphasizes this. He has been elected regional Vice President of the National Collegiate Athletic Association which gives him general supervision of common athletic interests among the colleges and universities of Delaware, New York, Pennsylvania, New Jersey and Maryland. For twenty-nine years Professor Diederichs has been active in athletic administration. Since 1907 when he was elected to the old Cornell Athletic Council he has participated in the direction of sports. In 1913 he was made President of the Cornell University Athletic Association and served in that office until he resigned in 1934 to become the Chairman of the Board of Athletic Policy which position he still holds.

This continuous service in the interests of Cornell athletics is not only a notable personal achievement, but has endeared him to the university undergraduates and alumni without regard to College and again marks him as an outstanding Cornellian.

Under date of April 1, more than 14,000 letters were sent out to Cornell engineers. This marks the readoption of our annual letter to communicate with each of our alumni and review the activities of the Society for their benefit. We hope that you who are already members will add your influence in increasing the membership of the Society among your friends so that an ever growing number will actively participate in the aims and objects of the Cornell Society of Engineers. Regional groups are now active and will give a large body of our members direct contact with the proceedings of the Society.

Remember Cornell Day, and act!

Sincerely yours,

EDWARD C. M. STAHL, '13, *President*

ALUMNI NOTES

'99 C.E.—Ernest D. Button, who is president of the J. B. Lang Engine and Garage Co. of Ithaca, recently presented the point-of-view of the small employer at a legislative hearing in Albany in opposition to the New York State Unemployment Insurance Act. He favors the passing of the Brownell Bill which would create a commission to determine the cause of unemployment in the State.

'14, '15, '17 M.E.—Latham W. Murfey '14, Clarence R. Hayes '15, and W. Griffin King '17 are general partners in the brokerage firm of Murfey, Blossom and Co., organized in January 1936 for the term of one year. Murfey lives on Baldwin Rd., Kirtland Hills Lake country, Ohio; Hayes at 17 E. 89th St., New York City; and King's address is R.F.D. 2 Willoughby, Ohio. The firm has offices in New York City, Akron, and Cleveland, Ohio.

'15 E.E.—D. G. Kramar is now with the Pacific Gas & Electric Company, 245 Market St., San Francisco, Calif. His home address is 3163 Maxwell Ave., Oakland, Calif.

'17 E.E.—J. J. Ruis is the author of an article entitled "A New Trigger for Closing a Switch" which appeared in the December issue of "Electrical Engineering". He developed this device at the Renessealer Polytechnic Institute.

'18 E.E.—John W. Weigt is a department head in the office of the Electric Storage Battery Co., 25 W. 43rd St., New York City. He lives at 9 Grace Court, North, Great Neck, N. Y.

'18 M.E.—Charles F. "Mike" Hendrie is now holding down the job of assistant manager of the steam power division of the Worthington Pump and Machinery Corporation, in Harrison, N. J. His home address is 250 Highland Ave., Newark, N. J.

'20 M.E.—Geroge Craydon Curtis is district manager of the Rochester Gas & Electric Co., for the lake shore district covering Wayne and Cayuga Counties. His first child, G. G. C., Junior, was born January 4, 1936. Mr. Curtis lives in Wolcott, N. Y.

'21 C.E.—Waldemar Polack, resident engineer-inspector for the P.W.A. on the construction of school 19 in Rochester, is eager to get in touch with anyone from Cornell who knows him who is in Rochester. He can be reached at 465 Seward Street.

'23 M.E.—Earl K. Steven has been promotion manager of Electric World, a McGraw-Hill publication, since April 1, 1935. His address is Chateau Lafayette, Greenwich, Conn.

'23 E.E.—J. G. Tarboux, a member of the executive committee of the Southern District of the A.I.E.E., is working on the formation of a new section of the A.I.E.E. in Knoxville and East Tennessee. He is a Professor at the University of Tennessee.

'24 M.E.—John C. Gibb married Parmelia Jacobs of Nutley, N. J. on February 7.

'24 E.E.—George S. Bibbins is an engineer with the long lines department of the A.T. & T., at 32 Sixth Ave., New York City. He lives at 30 Pine Terrace, East, Short Hills, N. J.

'24 E.E.—Henry J. McCracken is junior electrical engineer with the Bureau of Power and Light of Los Angeles, office in Arcade Building, Box 240. He lives at 9108 W. Adams St., Los Angeles. He recently became the proud father of another daughter.

'31 C.E. B. Otto Roessler is now working for the

dams designing division, Bureau of Reclamation, Denver, Colo. He resigned in January from the Bureau of Sewers of Baltimore. His new address is 930 Downing St., Denver.

'35 C.E.—Charles C. Spencer is employed by Greeley & Hansen, who are the engineers for the Buffalo sewer authority. His office is located at 263 Ashland Ave., Buffalo, New York.

'35 E.E.—Herbert L. Prescott is now at work in the transformer engineering department of the Westinghouse Electric Co. His new address is 1049 Alcoma St., Sharon, Pennsylvania.

'35 C.E.—Haywood G. Dewey, jr., is employed as a junior engineer in the Bureau of Reclamation in the hydraulic studies laboratories. He may be reached at Room 423 Y.M.C.A. Building, Denver, Colorado.

'35 M.E.—Odo J. Cilia has been working for the Mississippi River Commission, Waterways Experiment Station, at Vicksburg since February 5 in the capacity of junior engineering aide. He is living at Room 426, % Y.M.C.A., Vicksburg, Miss.

'35 E.E.—Earle R. Elmer, Jr., now has a job with the Girney Eelevator Co., of New York City.

'34 C.E.—H. Alfred Stalfort, a member of the Cornell Club of Maryland and the Engineers Club of Baltimore, is working as assistant manager of the building department for the Consolidated Engineering Co. of Baltimore. His address is 20 East Franklin St., Baltimore.

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Cornell Engineers

(*Continued from page one hundred sixty-seven*)

service for New York State which still continues. From 1906 to 1913, he was appointed, after Civil Service examination, Special Assistant Engineer to the Board of Health of New York State and for a time acted as Chief Engineer.

His greatest service to New York State began in 1913 upon his appointment to the newly-created Public Health Council. In this respect, his technical and general ability have been repeatedly recognized for he has been reappointed by each Governor since 1913. Three years ago, it was his extreme pleasure to welcome President Livingston Farrand to the Council. In his connection with the Council, he has gained much valuable experience. It has taught him a kind of patience that can't be acquired in any other way. Moreover, he hasn't lost faith in politics because it has always been his good fortune to be associated with admirable men. Many of his former students will recall that through his contacts on the Council he has helped them to good positions.

As an author, he has written four texts pertaining to sewerage and rural hygiene besides many articles for publication in trade and society journals.

For the past five years, he has been a trustee of Wells College and Chairman of its Educational Committee. He was also a trustee for the St. Faiths School at Saratoga Springs, N. Y., and St. Stephens College at Annandale, N. Y. At Cornell, he is a member of the Standing Committee on Hygiene and Preventive Medicine, representing the engineering side. In the City of Ithaca, he was President of the Board of Trustees for the Ithaca City Hospital for six years and supervised the construction of the nurses' home and the power plant.

Election to Honorary Membership in the Association of Managers of Sewage Disposal Plants of England brought him great pleasure because he believes that they are a group of men who know their business well. He is also a member of the American Society of Civil Engineers, the American Society of Municipal Improvements, the Royal Sanitary Institute of Great Britain, a Fellow of the American Public Health Association, and a member of the Cornell Club of New York. Besides all of these, he also belongs to Pyramid and Sigma Xi, and is the present Secretary of the Class of '89.

He married Georgiana Mary Smith of Portland, Maine, in 1895. They have had seven children.

At the end of this school year, Professor Ogden is to retire from active duties at Cornell and bring to a close a splendid career of 45 years of teaching. As he retires, he will long be remembered for his accomplishments as a public-minded citizen and for his broad, enthusiastic and inspiring teachings.

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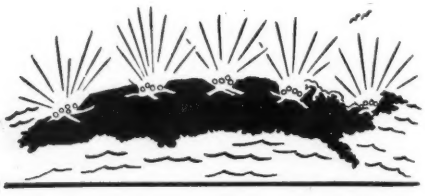
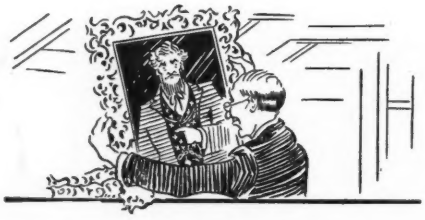
G-E *Campus News*



MORE BRIGHT SPOTS ON THE GLOBE

THE mellow, golden-orange glow of sodium lighting is springing up all across the continent. The latest installation, the largest in the United States, is located in the state of Washington. Here sixty-six 10,000-lumen General Electric units line almost three miles of the four-lane Pacific highway between Tacoma and Fort Lewis.

Less than three years ago the sodium lamp made its first American appearance on a highway near Schenectady. Today the largest installation is on the Pacific coast, and the second-largest is at Lynn, Mass., on the Atlantic. In between, highways, bridges, traffic circles, and underpasses are being lighted for safety with these new luminaires, and G-E sodium lighting units have been installed in Canada, Hawaii, India, Spain, South Africa, Dutch East Indies, and Brazil.



X-RAY FOR ART'S SAKE

IS there a portrait of Great Uncle Ezra gathering dust in the attic? It may pay to x-ray Uncle before handing him over to the junkman, for behind Ezra's imposing whiskers may be hiding the sister of the Mona Lisa.

Not long ago, a portable G-E X-Ray Corporation unit disclosed a valuable canvas by the seventeenth-century artist, Goya, concealed under an apparently worthless picture. More recently a New Orleans painter and art expert has used the x-ray to discover a genuine da Vinci signature beneath layers of paint applied by a later and less-capable artist. A sister painting to the newly found da Vinci recently sold for a quarter of a million dollars.

The x-ray does more than discover lost Old Masters; it tells how the great artists of the past worked. A series of radiographs can disclose the full story of their brushwork from the first rough sketch to the last correction and afterthought. The art student of today, by an intelligent use of the x-ray, is in a position to take lessons from the geniuses of the past.

NO CLICK!

THE life of the party, coming home with the milkman, need no longer fear the betraying click of the light switch if his house wiring includes the latest electric switch developed in the G-E Research Laboratory.

Two shallow chrome-steel cups, sealed together with a strip of glass, form the two contacts. A ceramic disk with a hole in it, and a few drops of mercury, partly fill the enclosure between the cups. The device is filled with hydrogen and sealed by welding. In the "off" position, the hole in the disk is above the mercury level. A rotation of twenty degrees to the "on" position permits the mercury to flow through the hole and make the electric connection.

The time-honored click of the switch is abolished. In the laboratory in Schenectady, one of these mercury switches has turned a 200-watt lamp on and off some 65 million times in the last two years, and there are no signs of wearing out or failure.

96-245DH

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